

working nine hours the first day, nine and three-quarter hours the second, third, and fifth days, and nine and one-quarter hours the fourth day; the average strokes of the engine being thirty-three per minute, and the average depth of water that the buckets were working at twenty feet, or the performance of 236 cubic yards per engine hour. The performance of grapple dredges in the United States in good-lifting material has considerably exceeded the above; and the American Dredging Company's No. 4 grapple is now making a weekly average of 2,480 cubic yards per day of seven hours' work, or more than 300 cubic yards per engine hour.

"The endless-chain dredgers cannot dredge close alongside of quay walls, wharfs, &c., unless the bucket-reel is placed on the outside of the dredge and the material elevated to a great height sufficient to secure its flow through long inclined chutes across the dredge into the loading barges on the opposite side. The grapple dredgers meet with no difficulty of this kind and need no special adaptation for such work.

"I saw no endless-chain dredgers at work or designed for operating in exposed localities. That system would be deemed very unserviceable for such work in the United States compared with the grapple dredgers now employed upon such work so efficiently, and with so little risk of injury.

"The use of endless-chain dredges for clearing docks, tidal basins, and narrow channels, &c., as observed at Liverpool and Birkenhead, serves in many cases to entirely interrupt traffic by reason of the hauling cables leading across the basins, and the dredge itself constantly moving back and forth while at work, or else the work of the dredging is continually interrupted, and at certain stages of the tides entirely suspended. For instance, at Birkenhead, where the entrance gates of the basin were opened for admission or removal of vessels, the dredger was removed from its work alongside the quay, where it remained idle till the gates were closed, when it was again placed in position, the hauling cables stretched across from side to side on the line of the 'cut' to be made, and the necessary side lines and anchors arranged before the work could proceed. The repetition of this at every tide must occasion much loss of time and needless expense, and could be wholly obviated by the use of the grapple dredge, which would have no lines out to interfere with passing vessels, the dredge being held in position securely by its speeds or heavy timbers let down through well-holes through the hull, to serve as anchors.

"With the endless-chain type it is necessary to continually move the dredger forward and backward, or sideways, and with considerable force in order to keep the buckets up to their work in the cut being made; while the grapple dredges make but comparatively few movements, and of several feet forward at a time as the bucket lifts vertically from the bed by successive grapples a cutting of greater width than the dredge itself, and to the required depth over all the space within the sweep of its boom, and need lines and anchors only in strong currents, tide-ways, and exposed localities.

"For cutting canals and draining ditches and forming embankments by placing the excavated material directly upon the bank on either side, the endless-chain dredges are not adapted. The grapple dredgers, however, will cut their own way their full width, and more, through low and marsh lands, uncovered even by high tides, and throw the material aside on either hand, or lift it into cars to be conveyed away.

"It will be noticed that in the endless-chain system it is necessary to elevate all the material lifted to a considerable height above the water surface (37 feet in No. 1, and 30 feet in No. 8 or No. 9 of the Clyde dredgers) in order to secure the proper inclination to the chutes for depositing it in the barge alongside. The American system elevates it sufficiently only for the bucket to swing clear of the barge-rail, and thereby saves the expenditure of about 175,000 foot pounds per minute in this work alone over the Clyde dredgers in their performance as quoted.

"The dredgers in France and Belgium seem of a rather lighter construction, with less ponderous and costly machinery, and in many cases the power is transmitted from the engine to the tumbler shaft gearing by leather belting.

"In a dredger at work on the canal enlargement, near Ghent, I noticed that the contractor's locomotive placed in the hold was supplying the motive power, and transmitting it through two 9-inch leather belts from the forward driving wheels.

"In the new harbour at the mouth of the North Sea Canal, in Holland, there were several sand-pumping dredges at work lifting the material through a tube by the suction of a centrifugal pump placed a few feet below the surface of the water, and operated by machinery from on board an old vessel temporarily fitted for the purpose; but the best performance reported to me was only about 70 cubic yards lifted per hour.

"All the dredging plant that I saw on the Continent was owned and operated by contractors instead of municipal and other corporations; and, therefore, I was unable to obtain much detailed information in regard to their cost of construction, operation, capacity, &c.

"There is no doubt whatever of the great superiority of the grapple-dredge system over the endless-chain type in nearly every material point, except perhaps in the excavation of excessively hard material like the 'till' found at Glasgow, which is certainly the most tenacious and difficult to move of any material that ever came under my observation. But for general river and harbour improvements in exposed and sheltered localities, deep and shallow excavations, cleaning docks, slips, and basins; draining, dyking, and reclaiming marsh lands; removing boulders, snags, and wrecks; lifting broken and blasted rocks; pulling piles and filling piers; and the depositing of all materials lifted into barges or scows on either side, or upon piers, or into cars or tramways alongside for transportation inland; for filling in low places, &c., the grapple dredges are beyond all question by far the best adapted, while the endless-chain dredgers are unable to fulfil many of these conditions at all. The great superiority as to general adaptation for all kinds of work, together with the very much less cost of construction, maintenance, and operation, renders any consideration of adding endless-chain dredger to your plant wholly inadvisable.

"F. C. PREINDLE, C.E."